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McDERMOTT, WILL & EMERY  
600 13th Street, N.W.  
Washington, DC 20005-3096

EXAMINER
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SMITH, JACKSON R

ART UNIT	PAPER NUMBER
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1709

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06/29/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

## Office Action Summary

Application No.

10/790,759

Applicant(s)

MARUYAMA, EIJI

Examiner

Jack Smith

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE \_\_\_\_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-5,8-11,14-16,19 and 20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5,8-11,14-16,19 and 20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date 5/10/07.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_.

## DETAILED ACTION

### *Information Disclosure Statement*

1. A duplicated reference disclosed earlier in the Notice of References Cited form (PTO-892) sent with the office action dated 3/23/07 has been lined through on the Information Disclosure Statement that was submitted on 5/10/07.

### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1 – 5, 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Inoue et al. (US Patent 5,344,498) in view of Neerinck et al. (D.G. Neerinck and T.J. Vink, Thin Solid Films 278 (1996) 12-17) and in further view of Adurodija et al. (F.O. Adurodija, H. Izumi, T. Ishihara, H. Yoshioka and M. Motoyama, J. Appl. Phys. 88 (2000) 4175-4180).

As to claim 1, Inoue et al. teaches a photovoltaic device (a-Si solar cell element, 100, Figure 1) comprising: a photoelectric conversion layer (a-Si semiconductor layer, 103; Column 7, lines 22 - 26) receiving light incident from the front surface side (i.e., incident on the side of the element bounded by 104); and a transparent conductive film (transparent conductive layer, 104), formed on the front surface of said photoelectric

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conversion layer, wherein the transparent conductive layer is indium oxide (indium tin oxide, ITO, Column 8, lines 6 – 11). Inoue fails to provide is an explicit disclosure of indium oxide layers having (222) plane orientation with two (222) peaks in said indium oxide layer.

Neerick et al. disclose an indium tin oxide film suitable for use in optoelectronic applications as a transparent conductor (Introduction, 1<sup>st</sup> paragraph). As shown in Figure 1, this film has a (222) plane orientation with two (222) peaks ("doublet-type peak profile," figure caption) in its x-ray diffraction spectrum.

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the ITO films taught by Neerick et al. as the transparent conductor in the device of Inoue et al. in order to provide low resistivity and high transmissivity to visible light in the electrode (Introduction, 1<sup>st</sup> paragraph). Further, Inoue et al. suggests using ITO deposited using the general methods, sputtering, used by Neerick et al. However, the modified device of Inoue et al. lacks a specification that the content of Sn in the indium tin oxide layer with respect to In is at least about 2 percent by weight and not more than about 7 percent by weight.

Adurodija et al. teach a series of composition for ITO films that may be used in "many optoelectronic applications, including flat panel displays and solar cells" (Introduction, first paragraph). As Adurodija et al. show in Figure 4a, the carrier concentration of these films increases with weight % of Sn from 0-6 wt. % and then either decreases or levels off from 6-10 wt. % Sn. Thus, Adurodija et al. show in this figure that the maximum carrier concentration for these films occurs around 6 wt. % Sn.

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Adurodija et al. disclose in first paragraph of the introduction that high carrier concentration and low resistivity are optimal for use in solar cell applications as transparent conductors. It would have been obvious to one of ordinary skill in the art at the time of the invention to choose a composition of the tin oxide layer used as the transparent conductive layer in the device of Inoue et al. that is around 6 wt. % Sn as instructed by Adurodija et al. in order to optimize the carrier concentration of the film.

As to claim 2, the photovoltaic device of Inoue et al. comprises a semiconductor layer (a-Si semiconductor layer, 103; Column 7, lines 22 - 26), formed on said transparent conductive film, that consists of an amorphous semiconductor (i.e., amorphous silicon).

As to claim 3, said (222) peaks in Figure 1 of Neerinck et al. for the indium tin oxide transparent conductor include: a first peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.1 \pm 0.1$  degrees, and a second peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.6 \pm 0.1$  degrees.

As to claim 4, the ratio ( $I_1/I_2$ ) of the intensity of said first peak ( $I_1 \approx 2.5$ , in arbitrary units, according to Figure 1 of Neerinck et al.) to the intensity of said second peak ( $I_2 \approx 5.5$ , in arbitrary units, according to Figure 1) is approximately 0.46.

As to claim 5, the ratio ( $I_1/I_2$ ) of the intensity of said first peak ( $I_1 \approx 2.5$ , in arbitrary units, according to Figure 1 of Neerinck et al.) to the intensity of said second peak ( $I_2 \approx 5.5$ , in arbitrary units, according to Figure 1) is approximately 0.46.

As to claim 15, the photovoltaic device (a-Si solar cell element, 100, Figure 1) of Inoue et al. is a device that has a transparent conductive film (transparent conductive

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layer, 104) and comprises: a substrate (substrate, 101); and a transparent conductive film (transparent conductive layer, 104), formed on said substrate. While the transparent conductive layer disclosed by Inoue et al. is generic, it suggests an indium oxide layer (indium tin oxide, ITO) as the transparent conductive layer in Column 8, lines 6 – 11. Inoue fails to provide is an explicit disclosure of indium oxide layers having (222) plane orientation with two (222) peaks in said indium oxide layer.

Neerick et al. disclose an indium tin oxide film suitable for use in optoelectronic applications as a transparent conductor (Introduction, 1st paragraph). As shown in Figure 1, this film has a (222) plane orientation with two (222) peaks ("doublet-type peak profile," figure caption) in its x-ray diffraction spectrum. It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the ITO films taught by Neerick et al. as the transparent conductor in the device of Inoue et al. in order to provide low resistivity and high transmissivity to visible light in the electrode (Introduction, 1st paragraph). Further, Inoue et al. suggests using ITO deposited using the general methods, sputtering, used by Neerick et al. However, the modified device of Inoue et al. lacks a specification that the content of Sn in the indium tin oxide layer with respect to In is at least about 2 percent by weight and not more than about 7 percent by weight.

Adurodija et al. teach a series of composition for ITO films that may be used in "many optoelectronic applications, including flat panel displays and solar cells" (Introduction, first paragraph). As Adurodija et al. show in Figure 4a, the carrier concentration of these films increases with weight % of Sn from 0-6 wt. % and then

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either decreases of levels off from 6-10 wt. % Sn. Thus, Adurodija et al. show in this figure that the maximum carrier concentration for these films occurs around 6 wt. % Sn. Adurodija et al. disclose in first paragraph of the introduction that high carrier concentration and low resistivity are optimal for use in solar cell applications as transparent conductors. It would have been obvious to one of ordinary skill in the art at the time of the invention to choose a composition of the tin oxide layer used as the transparent conductive layer in the device of Inoue et al. that is around 6 wt. % Sn as instructed by Adurodija et al. in order to optimize the carrier concentration of the film.

As to claim 16, said (222) peaks of said indium tin oxide transparent conductor of Neerincx et al. include: a first peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.1 \pm 0.1$  degrees, and a second peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.6 \pm 0.1$  degrees (Figure 1).

4. Claims 8 – 11, 14, 19 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakamura et al. (US Patent 7,030,413 B2) in view of Vink et al. (T.J. Vink, W. Walrave, J.L.C. Daams, P.C. Baarslag, J.E.A.M. van den Meerakker, Thin Solid Films 266 (1995) 145-151) and in further view of Adurodija et al. (F.O. Adurodija, H. Izumi, T. Ishihara, H. Yoshioka and M. Motoyama, J. Appl. Phys. 88 (2000) 4175-4180).

As to claim 8, Nakamura et al. discloses a photovoltaic device (photovoltaic device, Figure 1) comprising: a first conductivity type crystalline semiconductor substrate (n-type single crystalline Si, 11) having a front surface and a back surface and receiving light incident from the side of said front surface; a substantially intrinsic first

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amorphous semiconductor layer (the layer formed by the combination of intrinsic amorphous SiC and Si, layers 13 and 14) formed on said front surface of said crystalline semiconductor substrate; a second conductivity type second amorphous semiconductor layer (p-type amorphous Si, 14) formed on said first amorphous semiconductor layer; and a transparent conductive film (transparent electrode, 15), formed on said second amorphous semiconductor layer. Nakamura teaches that the transparent conductive film is an indium oxide layer (indium tin oxide, Column 4, lines 34-35). What Nakamura fails to provide is an indium oxide layer having (222) plane orientation with two (222) peaks in said indium oxide layer.

Vink et al. disclose an indium tin oxide film suitable for use in optoelectronic applications as a transparent conductor (Introduction, 1<sup>st</sup> paragraph). The x-ray diffraction pattern of one such film, i.e., a film that is annealed and sputter-deposited at room temperature according to the teachings of Vink et al., appears in Figure 1 of Neernick et al. As shown in Figure 1, this film has a (222) plane orientation with two (222) peaks ("doublet-type peak profile," figure caption) in its x-ray diffraction spectrum. Further, Vink et al. report results showing that annealed, tin oxide films sputter deposited at room temperature on tin oxide films have low intrinsic stress (Conclusion paragraph, 2<sup>nd</sup> to last sentence). Vink et al. further disclose that the use of indium tin oxide films with low internal stress is advantageous to prevent deformation and fracture (Introduction, 1<sup>st</sup> paragraph). The indium oxide film of Nakamura et al. was sputter deposited at a substrate temperature of 180°C, well over 100°C in excess of room temperature, which would leave it prone to internal stress. Therefore, it would have



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been obvious to one of ordinary skill in the art at the time of the invention to replace the transparent conductive film in Nakamura et al. by a film sputter deposited at room temperature and annealed according to the teachings of Vink et al. in order to prevent deformation and fracture. However, the modified device of Nakamura et al. lacks a specification that the content of Sn in the indium tin oxide layer with respect to In is at least about 2 percent by weight and not more than about 7 percent by weight.

Adurodija et al. teach a series of composition for ITO films that may be used in "many optoelectronic applications, including flat panel displays and solar cells" (Introduction, first paragraph). As Adurodija et al. show in Figure 4a, the carrier concentration of these films increases with weight % of Sn from 0-6 wt. % and then either decreases or levels off from 6-10 wt. % Sn. Thus, Adurodija et al. show in this figure that the maximum carrier concentration for these films occurs around 6 wt. % Sn. Adurodija et al. disclose in first paragraph of the introduction that high carrier concentration and low resistivity are optimal for use in solar cell applications as transparent conductors. It would have been obvious to one of ordinary skill in the art at the time of the invention to choose a composition of the tin oxide layer used as the transparent conductive layer in the device of Nakamura et al. that is around 6 wt. % Sn as instructed by Adurodija et al. in order to optimize the carrier concentration of the film.

As to claim 9, said (222) peaks in Figure 1 of Neerincx et al. include: a first peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.1 \pm 0.1$  degrees, and a second peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.6 \pm 0.1$  degrees.

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As to claim 10, the ratio ( $I_1/I_2$ ) of the intensity of said first peak ( $I_1 \approx 2.5$ , in arbitrary units, according to Figure 1 of Neernick et al. ) to the intensity of said second peak ( $I_2 \approx 5.5$ , in arbitrary units, according to Figure 1) is approximately 0.46.

As to claim 11, the ratio ( $I_1/I_2$ ) of the intensity of said first peak ( $I_1 \approx 2.5$ , in arbitrary units, according to Figure 1 of Neernick et al.) to the intensity of said second peak ( $I_2 \approx 5.5$ , in arbitrary units, according to Figure 1) is approximately 0.46.

As to claim 14, in the photovoltaic device of Nakamura et al. (photovoltaic device, Figure 1), said crystalline semiconductor substrate (n-type single crystalline Si, 11) is an n-type semiconductor substrate, and said second amorphous semiconductor layer is a p-type semiconductor layer (p-type amorphous Si, 14).

As to claim 19, in the photovoltaic device of Nakamura et al. (photovoltaic device, Figure 1), the first conductivity type single-crystalline silicon substrate (n-type single crystalline Si, 11) has a front surface and a back surface and receiving light on the side of said front surface; a substantially intrinsic first amorphous silicon layer formed on said front surface of said single- crystalline silicon substrate (the layer formed by the combination of intrinsic amorphous SiC and Si, layers 13 and 14); a second conductivity type second amorphous silicon layer formed on said first amorphous silicon layer (p-type amorphous Si, 14); and a transparent conductive film, formed on said second amorphous silicon layer, including an indium oxide (indium tin oxide, Column 4, lines 34-35). What Nakamura fails to provide is an indium oxide layer having (222) plane orientation with two (222) peaks in said indium oxide layer.

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Vink et al. disclose an indium tin oxide film suitable for use in optoelectronic applications as a transparent conductor (Introduction, 1<sup>st</sup> paragraph). The x-ray diffraction pattern of an example of one film sputter deposited at room temperature and annealed according to the teachings of Vink et al. appears in Figure 1 of Neerincx et al.. As shown in Figure 1, this film has a (222) plane orientation with two (222) peaks ("doublet-type peak profile," figure caption) in its x-ray diffraction spectrum. Further, Vink et al. report results showing that annealed, tin oxide films sputter deposited at room temperature on tin oxide films have low intrinsic stress (Conclusion paragraph, 2<sup>nd</sup> to last sentence). Vink et al. further disclose that the use of indium tin oxide films with low internal stress is advantageous to prevent deformation and fracture (Introduction, 1<sup>st</sup> paragraph). The indium oxide film of Nakamura et al. was sputter deposited at a substrate temperature of 180°C, well over 100°C in excess of room temperature, which would leave it prone to internal stress. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to replace the transparent conductive film in Nakamura et al. by a film sputter deposited at room temperature and annealed according to the teachings of Vink et al. in order to prevent deformation and fracture. However, the modified device of Nakamura et al. lacks a specification that the content of Sn in the indium tin oxide layer with respect to In is at least about 2 percent by weight and not more than about 7 percent by weight.

Adurodija et al. teach a series of composition for ITO films that may be used in "many optoelectronic applications, including flat panel displays and solar cells" (Introduction, first paragraph). As Adurodija et al. show in Figure 4a, the carrier

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concentration of these films increases with weight % of Sn from 0-6 wt. % and then either decreases or levels off from 6-10 wt. % Sn. Thus, Adurodija et al. show in this figure that the maximum carrier concentration for these films occurs around 6 wt. % Sn. Adurodija et al. disclose in first paragraph of the introduction that high carrier concentration and low resistivity are optimal for use in solar cell applications as transparent conductors. It would have been obvious to one of ordinary skill in the art at the time of the invention to choose a composition of the tin oxide layer used as the transparent conductive layer in the device of Nakamura et al. that is around 6 wt. % Sn as instructed by Adurodija et al. in order to optimize the carrier concentration of the film.

As to claim 20, said (222) peaks in Figure 1 of Neerinck et al. include: a first peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.1 \pm 0.1$  degrees, and a second peak having an X-ray diffraction angle,  $2\theta$ , of about  $30.6 \pm 0.1$  degrees.

### ***Response to Arguments***

5. Applicant's arguments with regard to claims 1-7 and 15-18 have been fully considered but they are unpersuasive.

6. Applicant contends on page 7 that the cited references "fail to disclose" the limitation added by amendment to claims 1, 8, 15 and 19 that the content of Sn in the indium oxide layer is at least about 2 percent by weight and not more than about 7 percent by weight. Note that the amendment to each of these claims, i.e., the pertinent part to this discussion, is identical. The examiner agrees the references cited in the office action of 3/23/07 (i.e., Inoue et al. (US Patent 5,344,498), Neerinck et al. (D.G.

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Neerincx and T.J. Vink, Thin Solid Films 278 (1996) 12-17), Nakamura et al. (US Patent 7,030,413 B2) and Vink et al. (T.J. Vink, W. Walrave, J.L.C. Daams, P.C. Baarslag, J.E.A.M. van den Meerakker, Thin Solid Films 266 (1995) 145-151)) do not specify this particular composition of the indium tin oxide layer.

In response to the change introduced by this amendment, however, the examiner has introduced the reference Adurodija et al. (F.O. Adurodija, H. Izumi, T. Ishihara, H. Yoshioka and M. Motoyama, J. Appl. Phys. 88 (2000) 4175-4180) which clearly teaches this limitation in its Figure 4. As Adurodija et al. show in Figure 4a, the carrier concentration of these films increases with weight % of Sn from 0-6 wt. % and then either decreases or levels off from 6-10 wt. % Sn. Thus, Adurodija et al. show that the maximum carrier concentration for these films occurs around 6 wt. % Sn. Adurodija et al. disclose in first paragraph of the introduction that high carrier concentration and low resistivity are optimal for use in solar cell applications as transparent conductors.

### ***Conclusion***

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

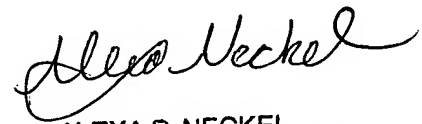
A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

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TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

JRS

JRS



ALEXA D. NECKEL  
SUPERVISORY PATENT EXAMINER